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AUTHOR Qvarnstrom, Bengt-Olof
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ABSTRACT

This examination of Richard Montague's grammar as it is manifested in his study, "The Proper Treatment of Quantification in Ordinary English" (PTQ) proposes that the theory contains significant flaws and raises fundamental methodological questions about the aims of logic and linguistics. The first part of this discussion presents the fragment of English used for analysis in PTQ and the semantic rules and postulates for the fragment. The functioning of the semantic rules is illustrated with an example. The second part assesses the PTQ's success in achieving two of its objectives: (1) construction of a device simulating the competent native speaker's metalinguistic behavior concerning sentences and arguments in the fragment, and (2) introduction of an intensional logic translating extensional English sentences into formulas resembling those of ordinary extensional (predicate) logic. The paper examines the role of the various semantic postulates with respect to these and other objectives. (MSE)

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MONTAGUE GRAMMAR AND THE AIMS OF LINGUISTICS AND LOGIC

by

BENGT-OLOF QVARNSTRÖM

University of Turku
Åbo Akademi

0. Introduction

One general aim of this paper is to reveal "the true nature of Montague grammar" as it is manifested in Richard Montague's 'The Proper Treatment of Quantification in Ordinary English' (henceforth abbreviated to PTQ). We think certain philosophers and especially certain linguists would have been less enthusiastic about PTQ if they had realized what it is really about.

The second general aim is to discuss certain fundamental methodological questions concerning the aims of logic and linguistics which PTQ has largely inspired us to ask.

Section 1 below is essentially of a preparatory character. The fragment of English specified in PTQ is presented as well as the semantic apparatus of the fragment, including its semantic rules and postulates. The functioning of the semantic rules is illustrated by means of an example. We do not, however, explicitly list or comment on the syntactic rules of the fragment in this paper, since these have been extensively discussed elsewhere (cf. Partee 1975, 1976).

In section 2 the important aim of PTQ is supposed to be the construction of a device, which simulates certain aspects of the competent native English speaker's metalinguistic behavior with respect to the (or only certain interesting) sentences, and arguments in the specified fragment of

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English. It is shown that PTQ is not entirely succesful in this respect. The introduction of an intensional logic which translates extensional English sentences into formulas resembling as much as possible the formulas of ordinary extensional logic (=predicate logic) normally representing extensional English sentences is assumed to be another, less important, aim of PTQ. The role of the various semantic postulates with respect to these and other aims is discussed.

1. Montague's fragment of English, its phrases, semantic rules, and semantic postulates

In the syntactic part of PTQ an infinite set of sequences of atomic expressions is defined with the help of an infinite set of basic phrases, BP, and a set of syntactic rules. The set of sequences is called a fragment of English, the reason for naming it thus obviously being that almost all native speakers of English would intuitively recognize many of the sequences as printed sentences or phrases of their mother tongue. BP is partitioned into subsets in such a way that every member of BP belongs to exactly one subset. The subsets and their respective members are

BP_{IV} = {run, walk, talk, rise, change}
BP_{T} = {John, Mary, Bill, ninety, he_0, he_1, he_2, ...}
BP_{TV} = {find, eat, lose, love, date, be, seek, conceive}
BP_{IAV} = {rapidly, slowly, voluntarily, allegedly}
BP_{Cn} = {man, woman, park, fish, pen, unicorn, price, temperature}
$BP_{t/t}$ = {necessarily}
$BP_{IAV/T}$ = {in, about}
$BP_{IV/t}$ = {believe that, assert that}
$BP_{IV//IV}$ = {try to, wish to}

When B is any of the indices attached to BP above, BP_B is read "the set of basic phrases of category B". We observe that any set of basic phrases of any category except of category T is finite and contains as members only entities which all competent native speakers of English would intuitively classify as printed words or phrases of their language. BP_T, however, is observed to be infinite and to contain he_0, he_1, he_2..., which most probably many native English speakers would not recognize as printed

words or phrases of their language.

With the help of the syntactic rules S1-S17 (cf. PTQ:224-5) the sets P_B are defined when B is any of the indices attached to BP above, or t. P_B is read "the set of phrases of category B". The indices attached to P are called categories. Consequences of the definition of the P_B:s are:

For all B, $BP_B \subseteq P_B$
$B_{IV} \subset P_{IV}$, $B_T \subset P_T$, $B_{TV} \subset P_{TV}$, $B_{IAV} \subset P_{IAV}$, $B_{Cn} \subset P_{Cn}$
$B_{t/t} = P_{t/t}$, $B_{IAV/T} = P_{IAV/T}$, $B_{IV/t} = P_{IV/t}$, $B_{IV//IV} = P_{IV//IV}$
For the category t, P_t is infinite, although PB_t is empty
For some category B, P_B is infinite and contains entities not recognized by many native English speakers as printed English sentences or phrases
Any element in any P_B belongs only to P_B.

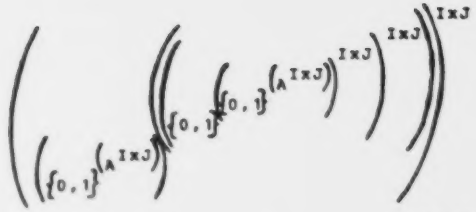
Given any three sets A, I, J (interpreted by Montague as the set of possible individuals, the set of possible worlds, and the set of moments of time, respectively the set of possible intensions corresponding to a given category B with respect to A, I and J is defined as follows:

The sets of possible intensions corresponding to IV, T, TV, IAV, Cn, t/t, IAV/T, IV/t, IV//IV, and t are

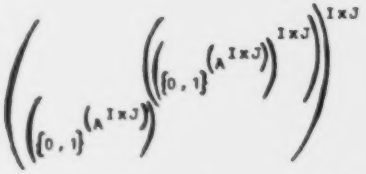
intensions corresponding to IV: $\left(\{0,1\}^{(A^{I\times J})}\right)^{I\times J}$

intensions corresponding to T: $\left(\{0,1\}^{\left(\{0,1\}^{(A^{I\times J})}\right)^{I\times J}}\right)^{I\times J}$

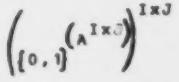
intensions corresponding to TV:



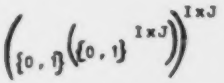
intensions corresponding to IAV:



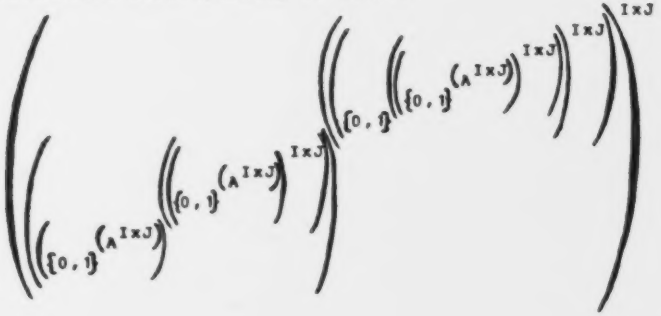
intensions corresponding to Cn:



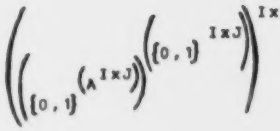
intensions corresponding to t/t:



intensions corresponding to IAV/T:



intensions corresponding to IV/t:



intensions corresponding to IV//IV:

$$\left(\left(\{0,1\}^{\left(A^{IxJ}\right)}\right)^{\left(\{0,1\}^{\left(A^{IxJ}\right)}\right)^{IxJ}}\right)^{IxJ}$$

intensions corresponding to t:

$$\{0,1\}^{IxJ}$$

It should be observed that the first and the fifth, and the fourth and the ninth sets are identical. As variables for elements in the first (=fifth), second, third, fourth (=ninth), sixth, seventh, eighth and the tenth set above are below used P and Q; W; Z; L; N; R; K and P, respectively. Later some other variables and sets are needed which it is convenient to introduce in this connection. As variables for elements in I, J, A, and A^{IxJ}, i; j; u and v; x, y and x_n (where n ranges over 0,1,2...), respectively, are used. M, S, U and G range over elements in

$$\left(\{0,1\}^{A}\right)^{IxJ} \quad , \quad \left(\left(\{0,1\}^{A}\right)^{A}\right)^{IxJ} \quad ,$$

$$\left(\left(\{0,1\}^{A^{IxJ}}\right)^{\left(A^{IxJ}\right)}\right)^{IxJ} \quad , \text{ and}$$

$$\left(\left(\left(\{0,1\}^{\left(A^{IxJ}\right)}\right)^{\left(\{0,1\}^{\left(A^{IxJ}\right)}\right)^{IxJ}}\right)^{A}\right)^{IxJ} \quad , \text{ respectively.}$$

The set of possible denotations (or extensions) corresponding to category B with respect to A, I, and J is arrived at by deleting the outermost IxJ in the expressions denoting the set of possible intensions corresponding to the category B with respect to A, I, and J.

An intensional model for the defined fragment of English (that is UP_B, where B varies as above stated) is a ninetuple $\langle A, I, J, j_o, m, b, n, \leq, F \rangle$ such that

(1) A, I, and J are non-empty sets
(2) j_o, m, b, and n are designated elements in $A^{I \times J}$ (the possibility that they are four, three, or two different elements of the same element in $A^{I \times J}$ is left open)
(3) $\leq$ is a simple (that is, a linear) ordering that has J as its field
(4) F is a function such that
  a. BP is its domain
  b. if α is in BP_B, then F(α) is in the set of possible intensions corresponding to B with respect to A, I, and J
  c. F(be) is the Σ such that for any i, j, W, and x, $\Sigma(i,j)(W)(x)=1$ iff $W(i,j)(P)=1$ where P is the function such that for any i', j', y, $P(i',j')(y)=1$ iff $x(i',j')=y(i',j')$
  d. F(necessarily) is the N such that for any i, j, and p, $N(i,j)(p)=1$ iff $p(i',j')=1$ for all i' and j'
  e. F(John) is the W such that for any i, j, and P, $W(i,j)(P)=1$ iff $P(i,j)(j_o)=1$
     F(Mary) is the W such that for any i, j, and P, $W(i,j)(P)=1$ iff $P(i,j)(m)=1$
     F(Bill) is the W such that for any i, j, and P, $W(i,j)(P)=1$ iff $P(i,j)(b)=1$
     F(ninety) is the W such that for any i, j, and P, $W(i,j)(P)=1$ iff $P(i,j)(n)=1$.

Suppose that $\mathcal{A} = \langle A, I, J, j_o, m, b, n \leq F \rangle$ is an intensional model for the defined fragment of English, and that g is an $\mathcal{A}$-assignment of values to the variables x,y, and x_n, that is, a function the domain of which is x,y, and x_n, and the values of which are in $A^{I \times J}$. Suppose also that F(he_n) is the W such that for any i, j, and P, $W(i,j)(P)=1$ iff $P(i,j)(g(x_n))=1$. Then the result of the definitions above is that, given an intensional model $\mathcal{A} = \langle A,I,J,j_o,m,b,n \leq F \rangle$ and an $\mathcal{A}$-assignment g, every basic phrase α of any category B has, in a very special way, associated with it relative to $\mathcal{A}$ and g exactly one function F(α) with domain IxJ in the set of possible intensions corresponding to B with respect to A,I, and J. This function is referred to by the expression $\alpha^{\mathcal{A}g}$ which is to be read "the intension of α with respect to $\mathcal{A}$ and g". By $\alpha^{\mathcal{A}g}(i,j)$, abbreviated to $\alpha^{\mathcal{A}ijg}$, are defined the denotations of α with respect to $\mathcal{A}$, i, j, and g. In the defined fragment of English are, however, not only basic phrases of any category associated relative to an $\mathcal{A} = \langle A,$

I,J,jo,m,b,n ≤ F⟩ and g with functions with domain IxJ, but also every non-basic phrase of any category B is relative to an $\mathcal{A}$ = ⟨A,I,J,jo,m,b,n ≤ F⟩ and g associated with exactly one or m o r e functions with domain IxJ contained in the set of possible intensions corresponding to category B with respect to A,I, and J. This Montague achieves by giving rules for expressing the functions or function associated with a non-basic phrase α of any category, in terms of the functions associated with the basic phrases from which α is ultimately derived with the help of the syntactic rules. The function associated with a non-basic phrase α is computed in a parallel manner in which α is syntactically derived in the sense that for every syntactic rule there is a corresponding semantic rule, which, applied to the functions associated with the phrases, from which α was derived by using the syntactic rule in question, gives the function associated with α. The rules for computing the $\alpha^{\mathcal{A}g}$:s (the intension(s) of α with respect to $\mathcal{A}$ and g or the function(s) associated with α relative to $\mathcal{A}$ and g) when α is any phrase of any category, are as follows:

T1 If $\alpha \in BP$, then $\alpha^{\mathcal{A}g} = F(\alpha)$

T2 If $\delta \in P_{Cn}$, then:

(a) <u>every</u> $\delta \in P_T$, and <u>every</u> $\delta^{\mathcal{A}g}$ is the function such that for any i, j, P, <u>every</u> $\delta^{\mathcal{A}ijg}(P)=1$ iff for all x, if $\delta^{\mathcal{A}ijg}(x)=1$, then $P(i,j)(x)=1$

(b) <u>the</u> $\delta \in P_T$, and <u>the</u> $\delta^{\mathcal{A}g}$ is a function such that for any i, j, P, <u>the</u> $\delta^{\mathcal{A}g}(P)=1$ iff there is exactly one x such that $\delta^{\mathcal{A}ijg}(x)=1$, and $P(i,j)(x)=1$

(c) <u>a(n)</u> $\delta \in P_T$, and <u>a(n)</u> $\delta^{\mathcal{A}g}$ is the function such that for any i, j, P, <u>a(n)</u> $\delta^{\mathcal{A}ijg}(P)=1$ iff there exists at least one x such that $\delta^{\mathcal{A}ijg}(x)=1$, and $P(i,j)(x)=1$

T3 If $\delta \in P_{Cn}$, $\phi \in P_t$, and $\alpha \in P_{Cn}$ is the result of applying the syntactic rule corresponding to T3 involving he_n or him_n to δ and ϕ, then $\alpha^{\mathcal{A}g}$ is the P such that for any i, j, x, $P(i,j)(x)=1$ iff $\delta^{\mathcal{A}ijg'}(x)=1$, and $\phi^{\mathcal{A}ijg'}=1$ where $g'(x_n)$ is x, and g' otherwise agrees with g.

T4 If $\alpha \in P_T$, $\delta \in P_{IV}$, and $\gamma \in P_t$ is the result of applying the syntactic rule corresponding to T4 to α and δ, then $\gamma^{\#ijg} = \alpha^{\#ijg}(\delta^{\#ig})$

T5 If $\delta \in P_{TV}$, $\beta \in P_T$, and $\gamma \in P_{IV}$ is the result of applying the syntactic rule corresponding to T5 to δ and β, then $\gamma^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T6 If $\delta \in P_{IAV/T}$, $\beta \in P_T$, and $\gamma \in P_{IAV}$ is the result of applying the syntactic rule corresponding to T6 to δ and β, then $\gamma^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T7 If $\delta \in P_{IV/t}$, and $\beta \in P_t$, then $\delta\beta \in P_{IV}$, and $\delta\beta^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T8 If $\delta \in P_{IV//IV}$, and $\beta \in P_{IV}$, then $\delta\beta \in P_{IV}$, and $\delta\beta^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T9 If $\delta \in P_{t/t}$, and $\beta \in P_t$, then $\delta\beta \in P_t$, and $\delta\beta^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T10 If $\delta \in P_{IV/IV}$, and $\beta \in P_{IV}$, then $\beta\delta \in P_{IV}$, and $\beta\delta^{\#ijg} = \delta^{\#ijg}(\beta^{\#ig})$

T11 If $\phi, \psi \in P_t$, then

(a) ϕ and $\psi \in P_t$, and ϕ and $\psi^{\#ijg} = 1$ iff $\phi^{\#ijg} = 1$, and $\psi^{\#ijg} = 1$

(b) ϕ or $\psi \in P_t$, and ϕ or $\psi^{\#ijg} = 1$ iff $\phi^{\#ijg} = 1$, or $\psi^{\#ijg} = 1$

T12 If $\gamma, \delta \in P_{IV}$, then

(a) γ and $\delta \in P_{IV}$, and γ and $\delta^{\#ijg}(x) = 1$ iff $\gamma^{\#ijg}(x) = 1$, and $\delta^{\#ijg}(x) = 1$

(b) γ or $\delta \in P_{IV}$, and γ or $\delta^{\#ijg}(x) = 1$ iff $\gamma^{\#ijg}(x) = 1$, or $\delta^{\#ijg}(x) = 1$

T13 If $\alpha, \beta \in P_T$, then α or $\beta \in P_T$, and α or $\beta^{\#ijg}(P) = 1$ iff $\alpha^{\#ijg}(P) = 1$, or $\beta^{\#ijg}(P) = 1$

T14 If $\alpha \in P_T$, $\phi \in P_t$, and $\psi \in P_t$ is the result of applying the syntactic rule corresponding to T14 involving he_n or him_n to α and ϕ, then $\psi^{\#ijg} = \alpha^{\#ijg}(P)$ where P is such that for any i', j', x, $P(i',j')(x) = 1$ iff $\phi^{\#i'j'g'} = 1$ where $g'(x_n)$ is x, and g' otherwise agrees with g.

T15 If $\alpha \in P_T$, $\beta \in P_{Cn}$, and $\gamma \in P_{Cn}$ is the result of applying the syntactic rule corresponding to T15 involving he_n or him_n to α and β, then $\gamma^{\mathcal{A}ig}$ is the P such that for any i, j, y, $P(i,j)(y)=1$ iff $\alpha^{\mathcal{A}ijg}(Q)=1$ where Q is such that for any i', j', x, $Q(i',j')(x)=1$ iff $\beta^{\mathcal{A}i'jig'}(y)=1$ where $g'(x_n)$ is x, and g' otherwise agrees with g

T16 is almost identical with T15; that is, we get T16 only by substituting P_{IV} for P_{Cn} in T15

T17 If $\alpha \in P_T$, $\delta \in P_{IV}$, and β is the result of applying operations F_{11}, F_{12}, F_{13}, F_{14}, and F_{15} of the corresponding syntactic rule S16 to α and δ, then

$\beta^{\mathcal{A}ijg}=1$ iff $\alpha^{\mathcal{A}ijg}(\delta^{\mathcal{A}ig})=0$

$\beta^{\mathcal{A}ijg}=1$ iff there is a j' $\neq$ j such that $\alpha^{\mathcal{A}ij'g}(\delta^{\mathcal{A}ig})=1$

$\beta^{\mathcal{A}ijg}=1$ iff for all j' $\neq$ j, $\alpha^{\mathcal{A}ij'g}(\delta^{\mathcal{A}ig})=0$

$\beta^{\mathcal{A}ijg}=1$ iff there is a j' $\neq$ j such that $\alpha^{\mathcal{A}ij'g}(\delta^{\mathcal{A}ig})=1$

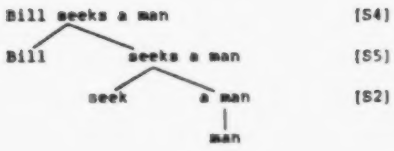
$\beta^{\mathcal{A}ijg}=1$ iff for all j' $\neq$ j, $\alpha^{\mathcal{A}ijg}(\delta^{\mathcal{A}ig})=0$,

respectively.

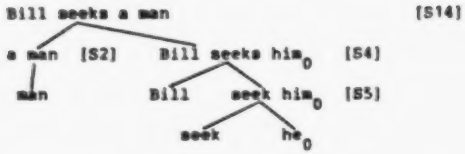
As can be seen, many of the semantic rules above have been formulated in such a manner that they contain the corresponding syntactic rule. It may also be mentioned that from the syntactic rule defining the fragment and the semantic rules defined for it, it follows that for $\alpha^{\mathcal{A}ig}$ to be more than one function it is necessary that α is syntactically derivable in more than one way.

Before continuing, we give an example which shows how Bill seeks a man$^{\mathcal{A}ig}$ is computed on the basis of, or expressed in terms of, the intensions of the basic phrases from which its syntactic derivation starts. We pay attention only to three different derivations of this phrase of category t which, like all phrases of this category, has infinitely many derivations. The following three trees indicate in a lucid manner how the phrase in question can be constructed. The phrase attached to a node in a tree is shown to be formed from phrases immediately below it and after any derived phrase the syntactic rule used in its derivation is mentioned.

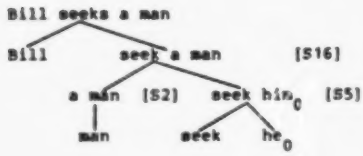
Derivation 1.



Derivation 2.



Derivation 3.



When Bill seeks a man is formed as indicated in derivation 1, Bill seeks a man$^{\alpha ij g}$ =1 iff Bill$^{\alpha ij g}$ (seeks a man)$^{\alpha g}$ = 1 (T4) iff F(Bill) (i,j)(Q)=1(T1) iff Q(i,j)(b)=1 (the definition of F(Bill)) where Q is such that for any i',j', Q (i',j') (y)=1 iff seek$^{\alpha i'j'g}$ (a man) (y)=1(T5) iff F(seek) (i',j') (W) (y) =1 where W is such that for any i",j", W(i",j") (P)=1 iff there exists at least one x such that F(man) (i",j") (x)=1 and P(i",j")(x)= 1 (T1 and T2).

This simplifies to Bill seeks a man$^{\alpha ij g}$= 1 iff F(seek)(i,j) (W)(b)=1 where W is such that for any i',j', W(i',j')(P)=1 iff there exists at least one x such that F(man) (i',j')(x)=1 and P(i',j')(x)=1.-- Thus, Bill seeks a man$^{\alpha g}$ is the p such that for any i,j,p(i,j)=1 iff (the statement

to the right of Bill seeks a man$^{\mathcal{A},i,j,g}$ above).

When the phrase in question is constructed according to derivation 2, Bill seeks a man$^{\mathcal{A},i,j,g}$ =1 iff a man$^{\mathcal{A},i,j,g}$ (P) =1 (T14) where P is such that for any i',j',x, P(i',j') (x)=1 iff Bill seeks him$_0^{\mathcal{A},i',j',g'}$ =1 iff Bill$^{\mathcal{A},i',j',g'}$ (seek him)$^{\mathcal{A},g'}$ =1 (T4) iff F(Bill) (i',j')(Q)=1 (T1) iff Q (i',j') (b)=1 (def. of F(Bill)) where Q is such that for any i",j",x Q(i",j") (y)=1 iff seek$^{\mathcal{A},i'',j'',g'}$ (he$_0^{\mathcal{A},g'}$) (y) =1(T5) iff F (seek) (i",j") F (he$_0$) (y) =1 (T1) where F(he$_0$) is such that for any i"',j"',P', F(he$_0$) (i"',j"') (P')=1 iff P'(i"',j"') (g'(x$_0$)=1 (definition of F(he$_0$)) and where g'(x$_0$) is x, and g' otherwise agrees with g. Using T2 and otherwise simplifying the right side we get Bill seeks a man$^{\mathcal{A},i,j,g}$=1 iff there exists at least one x such F(man) (i,j) (x)=1 and F(seek) (i,j) F(he$_0$) (b) =1 where F(he$_0$)is such that for any i',j',P, F (he$_0$) (i',j') (P)=1 iff P(i',j') (x)=1.-- Thus Bill seeks a man$^{\mathcal{A},g}$ is the p such that for any i,j, p(i,j) = 1 iff (the statement to the right of Bill seeks a man$^{\mathcal{A},i,j,g}$ above).

If our phrase is formed according to derivation 3, Bill seeks a man$^{\mathcal{A},i,j,g}$ =1 iff Bill$^{\mathcal{A},i,j,g}$ (seek a man$^{\mathcal{A},g}$) =1 (T4) iff F(Bill)(i,j) (Q)=1 (T1) iff Q(i,j)(b)=1 (def. of F(Bill)) where Q is such that for any i',j',x, Q(i',j') (y)=1 iff a man$^{\mathcal{A},i',j',g}$ (P)=1 where P is such that for any i",j",x, P(i",j") (x)=1 iff seek him$_0^{\mathcal{A},i'',j'',g'}$ (y)=1 (T16) iff seek$^{\mathcal{A},i'',j'',g'}$ (he$_0^{\mathcal{A},g'}$)(y)=1(T5) iff F(seek) (i",j")F(he$_0$)(y)=1 where F(he$_0$) is such that for any i"',j"',P, F (he$_0$) (i"',j"') (P')=1 iff P'(i"',j"') (g'(x$_0$)=1 and where g'(x$_0$) is x, and g' otherwise agrees with g. Using T2 and simplifying the right side we get the same result as in the second case.

It should be noted that Bill seeks a man$^{\mathcal{A},g}$ in each case above is the same irrespective of whether he$_{1(i\neq 0)}$ is used instead of he$_0$ in the syntactic derivations. The infinity of P_B for certain categories B is indeed due to the possibility of using alternatively different he$_i$ in the infinite set $\{he_0, he_1, he_2 \ldots\}$ in the way indicated.

Montague introduces what we would like to call a natural model for the defined fragment of English. Any intensional model $\mathcal{A} = \langle A, I, J, j_0, m, b, n \leq F \rangle$ for the defined fragment of English is a natural model for that fragment iff the following conditions hold for $\mathcal{A}$:

(I) There is at least one u such that for all i,j, u=j$_0$(i,j)
There is ... " u=m(i,j)
There is ... " u=b(i,j)
There is ... " u=n(i,j)

(II) For all x,i, and j, if F(δ) (i,j)(x)=1 where $\delta \in$ {man, woman, park, fish, pen, unicorn} then there exists at least one u such that for all i'

and j', u=x(i',j').

(III) There exists at least one M such that for all x,i, and j, $F(\delta)(i,j)(x)=1$ where $\delta \in \{$run, walk, talk$\}$ iff $M(i,j)(x(i,j))=1$

(IV) There exists at least one S such that for all x,W,i, and j, $F(\delta)(i,j)(W)(x)=1$ where $\delta \in \{$find, lose, eat, love, date, be$\}$ iff $W(i,j)(P)=1$ where P is such that for all i',j', and y, $P(i',j')(y)=1$ iff $S(i',j')(y(i',j'))(x(i',j'))=1$

(V) For all W there exists at least one M such that for all x,i, and j, $F(\delta)(i,j)(W)(x)=1$ where $\delta \in \{$seek, conceive$\}$ iff $M(i,j)(x(i,j))=1$

(VI) For all p there exists at least one M such that for all x, i, and j, $F(\delta)(i,j)(p)(x)=1$ where $\delta \in B_{IV/t}$ iff $M(i,j)(x(i,j))=1$

(VII) For all P there exists at least one M such that for all x,i, and j, $F(\delta)(i,j)(P)(x)=1$ where $\delta \in B_{IV//IV}$ iff $M(i,j)(x(i,j))=1$

(VIII) There exists a G such that for all W,Q,x,i,and j, $F(\delta)(i,j)(W)(Q)(x)=1$ where δ is in iff $W(i,j)(P)=1$ where P is such that for all i',j', and $\forall_y$ $P(i',j')(y)=1$ iff $G(i',j')(y(i',j'))(Q)(x)=1$

(IX) For all W,x,i, and j, $F(\text{seek})(i,j)(W)(x)=1$ iff $F(\text{try to})(i,j)(Q)(x)=1$ where Q is such that for all i',j', and $\forall_y$ $Q(i',j')(y)=1$ iff $F(\text{find})(i',j)(W)(y)=1$.

If $\alpha^{\wedge}$ or the $\alpha^{\wedge}$s is, or are, intended to be equivalents of some sort to the meaning or meanings of α, it is strange that the condition that F is a one-one function is not included among the conditions defining a natural model for the fragment. It is strange because if this condition is not imposed we may chose an F such that of any α and β in PB_B of any B, which all or almost all native speakers of English find to be non-synonymous phrases of their mother tongue, is predicted $F(\alpha) = \alpha^{\wedge} = F(\beta) = \beta^{\wedge}$. On the other hand, it should be noted that if Montague's aim in PTQ is what we later speculate it is, this condition is not needed. It should be observed that the principles (I)-(IX) cannot be given any literal intuitive natural interpretation even if A,I, and J are interpreted as the set of possible things, the set of possible worlds, and the set of moments of time, respectively, because it does not make sense to say that the extension of any basic phrase mentioned in the principles is a set of functions. For example, it is meaningless or false to say that man, pen, run(s), walk(s) etc. are in English predicated of functions x in $A^{I \times J}$. These expressions are in fact predicated of things which most probably correspond to the elements in A. We, however, do not think that Montague intended these principles to have any literal intuitive meaning, but that he only postulated them as theoretical, non-intuitive principles in order

to achieve certain desirable ends. (Later we shall comment more extensively on these principles.)

After presenting his principles, Montague defines certain important concepts. We now give these definitions, but we name the concepts differently. In the definitions below we assume that ϕ and ψ are phrases of category t and that the $\mathcal{A}$:s are natural models for the fragment.

- ϕ is 1-valued with respect to $\mathcal{A}ij$ iff $\phi^{\mathcal{A}ijg} = 1$ for every $\mathcal{A}$-assignment g.
- ϕ is necessarily 1-valued iff ϕ is 1-valued with respect to $\mathcal{A}ij$ for all $\mathcal{A}$, i, and j.
- A set $A \subseteq P_t$ implies the value of ψ iff for all $\mathcal{A}ij$, if every $\phi \in A$ is 1-valued with respect to $\mathcal{A}ij$, then ψ is 1-valued with respect to $\mathcal{A}ij$.
- The value of ϕ is necessarily equivalent with the value of ψ iff $\{\phi\}$ implies the value of ψ and vice versa.

2. The aim of PTQ

P_t includes elements of which many competent native speakers of English would truly predicate the following intuitions: "is an ambiguous sentence in the sense of having a de re (= referential, specific) and a de dicto (= non-referential, non specific) meaning", "is a non-ambiguous sentence in the sense of not having these two meanings", "is a sentence true by its meaning only", and "are cognitively synonymous sentences". P_t also contains elements from which could be constructed entities of which many competent native speakers of English would truly predicate the intuition "is a valid argument" or "is not a valid argument".

In PTQ "ϕ has a de re meaning" probably means "ϕ contains at least one phrase a(n)β, where β is in P_{Cn}, and at least one meaning of ϕ is such that the truth of ϕ with respect to that meaning at any given time i in the actual world implies the truth of "there exists a(n)β at time i in the actual world". The meaning of "ϕ has a de dicto meaning" in PTQ we presumably arrive at by replacing "implies" above, by "does not imply".

According to Montague, for example, any element in P_t of the form α seeks a β or of the form α tries to find a β, where α is in P_T and β in P_{Cn} is ambiguous (henceforth we use the word 'ambiguous' to refer to the kind of ambiguity introduced). On the other hand, no element in P_t of the form $\alpha\gamma$ a β where α and β are as above, and γ is in { finds, loses, eats, loves, dates, is } has this ambiguity according to Montague. Also,

John talks about a unicorn, John wishes to find a unicorn, a woman loves every man, and Mary believes that John finds a unicorn and he eats it are ambiguous according to Montague, but not John seeks a unicorn and Mary seeks it, John tries to find a unicorn and wishes to eat it, John wishes to find a unicorn and tries to eat it. Of course, given any of the sentences (with/or without the ambiguity) just listed, many other sentences in P_t of the same form (with/or without the ambiguity) could be constructed, by defining "being of the same form" in the proper way.

Montague does not explicitly mention any element in P_t which is true by its meaning only. As an example of this kind of sentence, John walks or John does not walk could perhaps be mentioned. As examples of synonymous elements in P_t only pairs of the form α seeks β, α tries to find β, where α and β are in P_T, are mentioned in PTQ.

An argument is an ordered pair the first member of which is a set of sentences (the premises), and the second element of which is exactly one sentence (the conclusion). For example, $\langle \{$John loves a pen and Bill walks$\}$, Bill walks $\rangle$ both sentences of which are in P_t, is an argument with exactly one premise. This argument is furthermore a valid argument (equivalently the conclusion is a logical consequence of the premises), since the truth of all the premises imply the truth of the conclusion, which is the defining property of the concept of a valid argument (or equivalently of the relation of logical consequence). Montague does not, however, explicitly mention this or any other valid argument consisting of elements in P_t. He only mentions explicitly some non-valid arguments (= arguments which are not valid) consisting of elements in P_t: $\langle \{$the temperature is ninety, the temperature rises$\}$, ninety rises$\rangle$ and $\langle \{$a price rises, every price is a number$\}$, a number rises$\rangle$.

We now think that the principal aim of Montague in PTQ is to account for the competent native English speaker's intuitions of the earlier mentioned type, in the sense of providing a device which simulates the competent native English speaker's behavior with respect to the sentences and arguments (or at least some explicitly mentioned sentences and arguments) in the fragment, when this behavior is restricted to the intuitions of the type mentioned. More precisely, we think that Montague wants to present a device which says of a sentence, of a pair of sentences, and of an argument, "is/is not ambiguous" "is/is not true by its meaning only", "are/are not synonymous", and "is/is not a valid argument", respectively, iff the native speaker predicates the same thing of that sentence, pair of sentences and argument, respectively. We think that the

principle reason for generating the fragment in the way it is done and for introducing exactly those semantic rules and semantic postulates presented in PTQ, is that all these things together are one way of achieving the desired end. This, however, is only true if certain conventions are agreed upon, which Montague has left unstated, probably because he considered them obvious. The first convention is

(a) ϕ containing $\underline{a(n)}\ \beta$ where $\beta \in P_{Cn}$, is ambiguous iff there are two ϕ's such that the definition of one implies "for any i,j there exists at least one x such that $F(\beta)(i,j)(x)=1$", and the definition of the other does not imply this. The ϕ' which implies this, corresponds to the de re meaning and the other to the de dicto meaning. (It should be noted that nothing in this convention depends on which natural model $\mathcal{A}$ is selected.)

Our example sentence in section 1, Bill seeks a man, is intuitively ambiguous and, as expected, Montague's simulating device predicts this property when the convention is adopted. In this example none of the semantic postulates are needed for successful simulation. Consider now the sentences Bill finds a pen and Bill talks in a park which both intuitively have only the de re meaning. Without using postulate (IV) and postulate (VIII) the device would, however, predict these and many other sentences to be ambiguous. We have not systematically checked for every sentence S in the fragment whether the device predicts of S what it should with respect to the ambiguity or non-ambiguity of S. By checking almost at random we have observed, however, that according to the device, for example, John tries to find a unicorn and wishes to eat it and John wishes to find a unicorn and tries to eat it[1] are ambiguous although for Montague intuitively they only have the de re meaning. The other conventions are

(b) ϕ is true by its meaning only iff ϕ is necessarily 1-valued

(c) $\langle A, \phi \rangle$ is a valid argument ($=\phi$ is a logical consequence of A) iff A implies the value of ϕ.

(d) ϕ and ψ are synonymous iff the value of ϕ is necessarily equivalent with the value of ψ.

Montague explicitly lists and discusses many ambiguous sentences. He

[1] Actually these sentences cannot be derived in the fragment although explicitly mentioned by Montague. However, with a slight reformulation of S4 which does not affect the corresponding semantic rule they could be derived.

mentions, however, only two arguments which intuitively according to him are invalid. No intuitively valid arguments are explicitly mentioned or discussed. Furthermore, only pairs of intuitively synonymous sentences of the type α seeks β , α tries to find β where α and β are in P_T, are mentioned. Because of this inexplicitness it is very hard to decide what postulates are needed for succesful prediction of these intuitions. The obvious exception is postulate (IX) which is needed for succesful simulation of synonymity of the type above. For example, no postulate is needed to predict the non-validness of the only two arguments explicitly treated by Montague. Perhaps, however, there are sentences or arguments in the fragment the intuitive properties of which could not be adequately predicted without postulates (I), (II), (III), (V), (VI), and (VII). On the other hand, there might be some other reason for introducing these postulates. To understand this reason we must present a feature of Montague's treatment of the fragment which we have left untouched until now. Montague does not directly associate functions with phrases in the way it has been described here, but does this indirectly through an intensional logic. The phrases of the fragment are in Montague's treatment "translated" to expressions or formulas of that logic, to which the functions are directly assigned, and by the translation relation they are then indirectly assigned to the phrases of the fragment. Now, it might be that certain of the postulates are needed only for the following purpose: every meaning of every sentence of the fragment should have at least one translation in the intensional logic which resembles as much as possible the translation of the meanings of this sentence into ordinary predicate logic (=extensional logic) (if the sentence has such translations), and which assigns the sentence the same functions as the other translations into intensional logic. Consider, for example, the following simple sentence Bill finds a pen which has at least the following three translations into intensional logic:

$$b^*(\hat{}\underline{\text{find}}(\hat{}\lambda P \forall x[\underline{\text{pen}}(x) \wedge [\check{}P](x)]))$$
$$\lambda P \forall x[\underline{\text{pen}}(x) \wedge [\check{}P](x)](\hat{}\lambda x_0[b^*(\hat{}\underline{\text{find}}(\hat{}\lambda P[[\check{}P](x_0)]))$$
$$b^*(\hat{}\lambda y[\lambda P \forall x[\underline{\text{pen}}(x) \wedge [\check{}P](x)](\hat{}\lambda x_0[[\underline{\text{find}}(\hat{}\lambda P[\check{}P(x_0)])](y)]))]$$

Each of these has associated with it the same function, as can be proved using postulate (IV). Now, using postulates (I), (II), and (IV), it can be proved that

$$\forall u[\underline{\text{pen}}_*(u) \wedge \underline{\text{find}}_*(b,u)]$$

(which is a formula in the intensional logic and very much resembles the formula in ordinary predicate logic to which the extensional sentence is normally translated) has the same function associated with it as the three formulas above. But why would Montague want this resemblance between a formula of his intensional logic (which translates a sentence in the fragment), and a formula of predicate logic normally representing this sentence? Perhaps because these formulas are simpler and therefore easier to work with and every person working in intensional logic knows predicate logic. Another reason might be that Montague was anxious to show the reasonableness of his complicated intensional logic by indicating that this logic gives almost the same logical representations of the extensional meanings of the sentences in the fragment, as predicate logic. It is of course possible that some postulates are introduced neither for the purpose of adequate simulation nor for the purposes just discussed. In that case the introduction of such postulates can only have an intuitive justification of some sort, that is, they are rigorous equivalents of some statements that appear to be intuitively true. The most reasonable candidates for this role are postulates (V)-(VII). Intuitively they seem to say the following:

(a) The truth value at time i in the actual world of any sentence of the form $\alpha\beta\gamma$ where α and γ are in P_T and β is seeks or conceives, depends only on what α refers to at time i in the actual world.

(b) The truth value at time i in the actual world of any sentence of the form $\alpha\beta\gamma$ where α is in P_T, and γ is in P_t, and β is asserts that or believes that, depends only on what α refers to at time i in the actual world.

(c) The truth value at time i in the actual world of any sentence of the form $\alpha\beta\gamma$ where α is in P_T, γ is in P_{IV}, and β is tries to or wishes to, depends only on what α refers to at time i in the actual world.

3. Main conclusion

The Montague grammar in PTQ is very interesting, (a) because it successfully simulates certain intuitions of the native speakers of English concerning the sentences and arguments in the fragment of English in PTQ, and (b) because the intuitions are of the type that linguists of late have tried to explain.

As a simulating device the grammar in PTQ is, however, purely ad hoc, and therefore cannot e x p l a i n , at least not in any normal sense, the intuitions which it is concerned with.

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